

WE1G - 1

# Improving the Short-Range Perception of MIMO Radars with LO Feedthrough Topologies by Complex Sampling

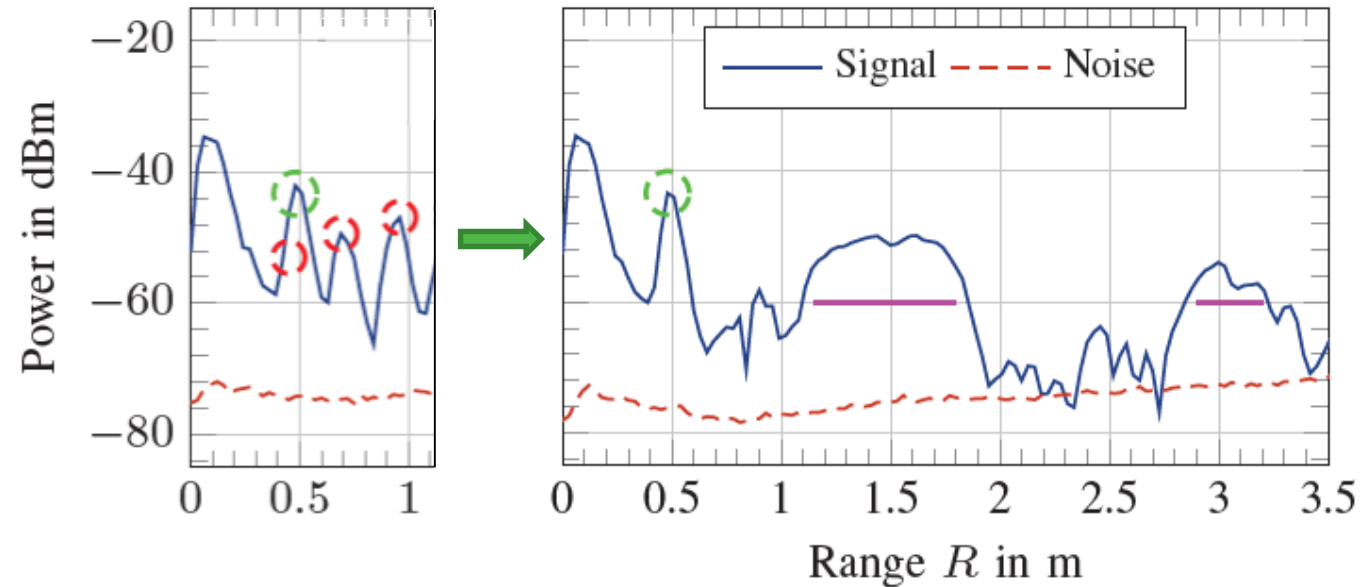
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Institute of Microwave Engineering, Ulm University, Germany

- Need for high-resolution 4D radars
  - ADAS and autonomous driving
  - Very high channel counts
- Other system topologies
  - LO Feedthrough

→ Induces image peaks
- Complex sampling ✓



[1]



[1] S. Sun et al., "MIMO Radar for Advanced Driver-Assistance Systems and Autonomous Driving: Advantages and Challenges," IEEE Signal Processing Magazine, vol. 37, no. 4, Jul. 2020.



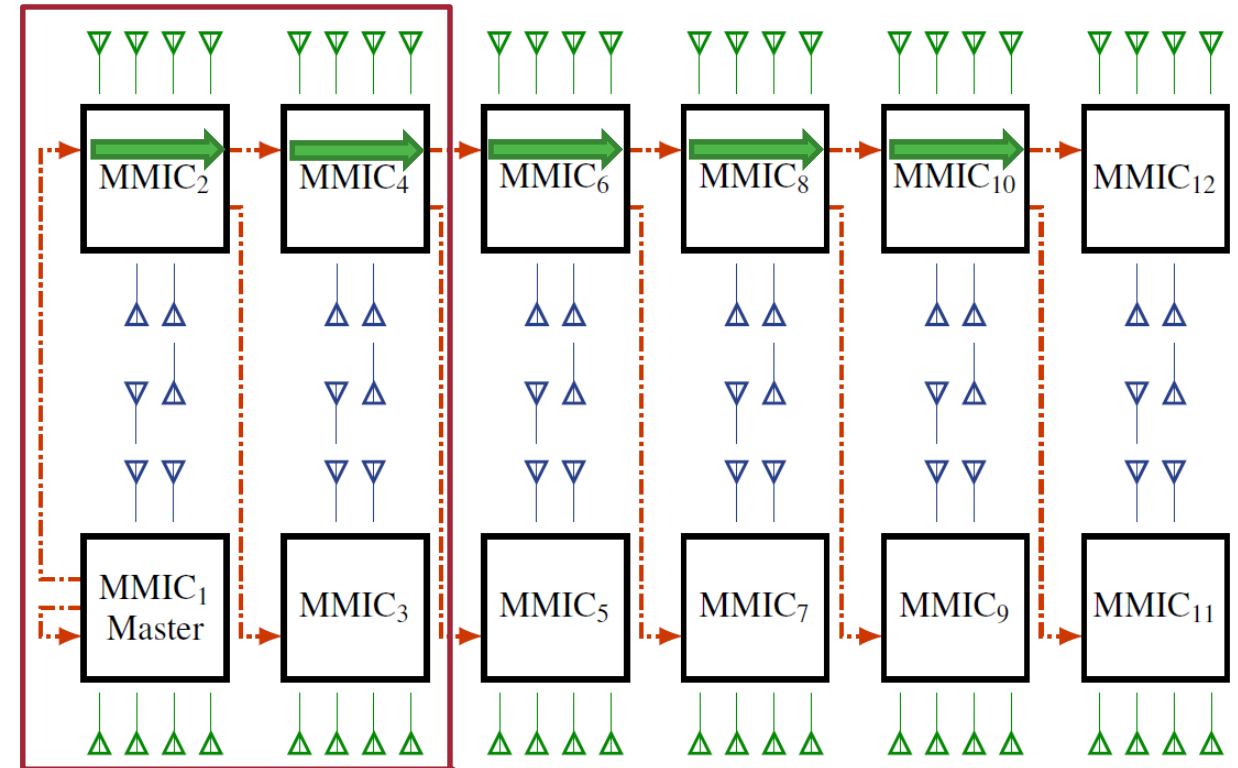
**Next Generation Radar Sensor Concept**

**Complex Sampling & LO Feedthrough**

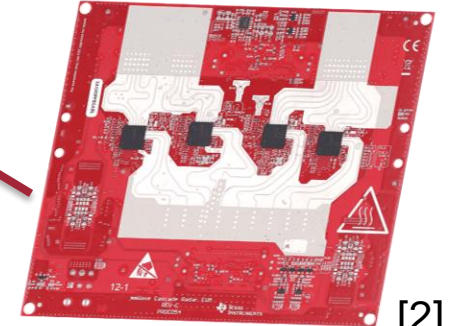
**Verification by Radar Measurements**

**Short-Range Parking Scenario**

- State-of-the-art
  - Cascading 4 MMICs
  - LO: Coherent divider network
- Next generation
  - Cascading 12 MMICs for 1728 virtual radar channels
- Mixed topology for LO
  - Feedthrough and divider network



 LO

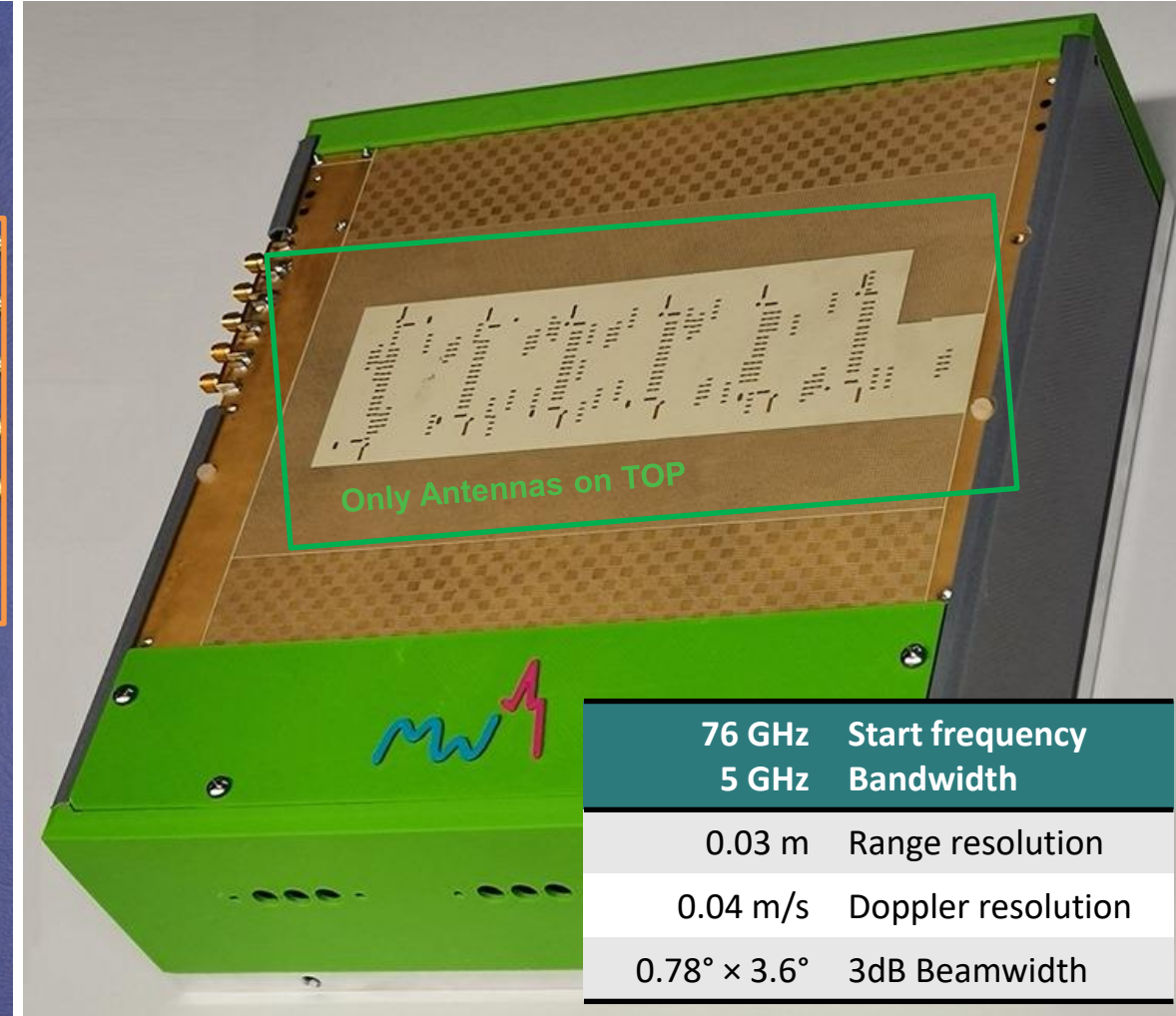
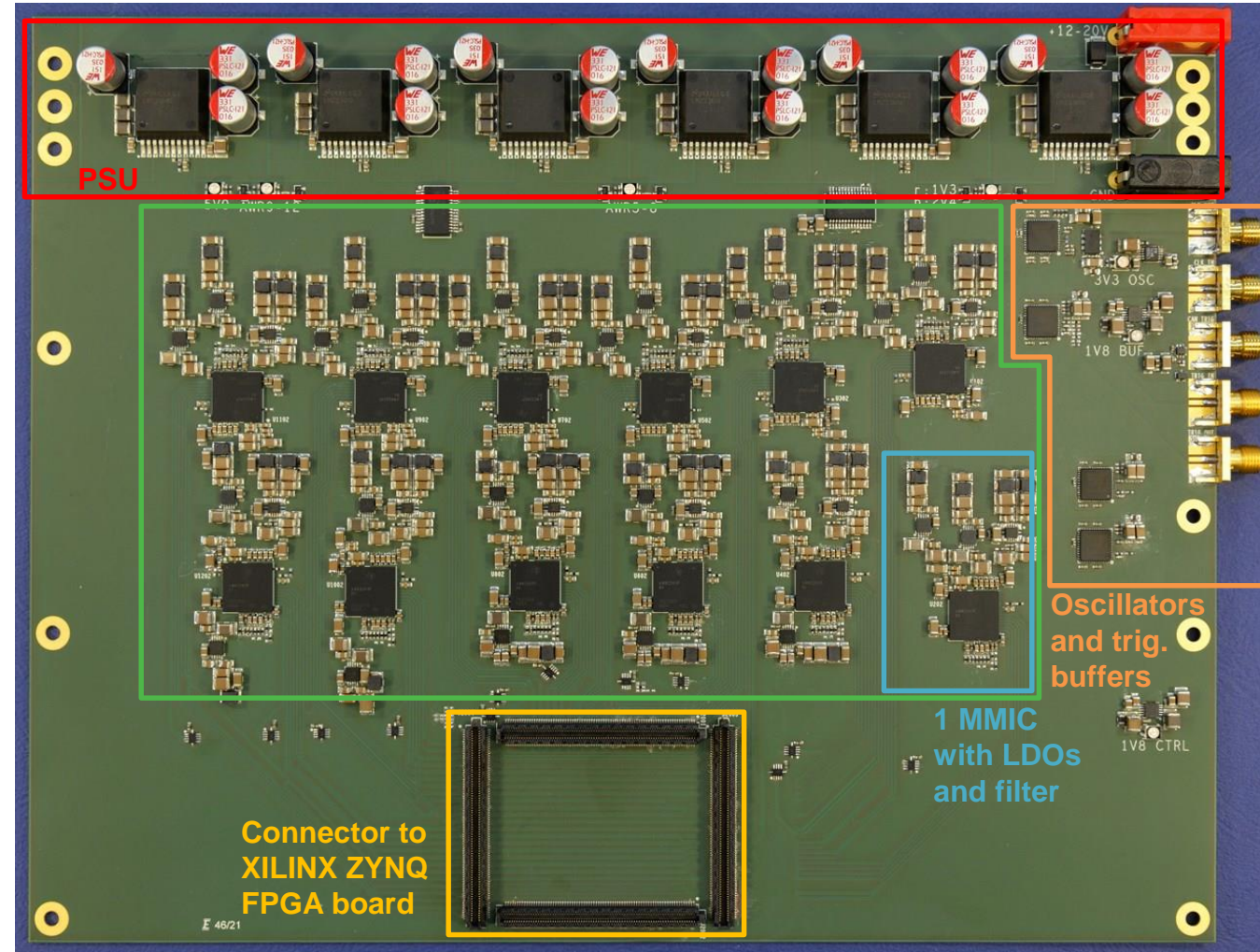


[2]

[2] Texas Instruments Incorporated, MMWCAS-RF-EVM mmWave cascade imaging radar RF evaluation module bottom board image.

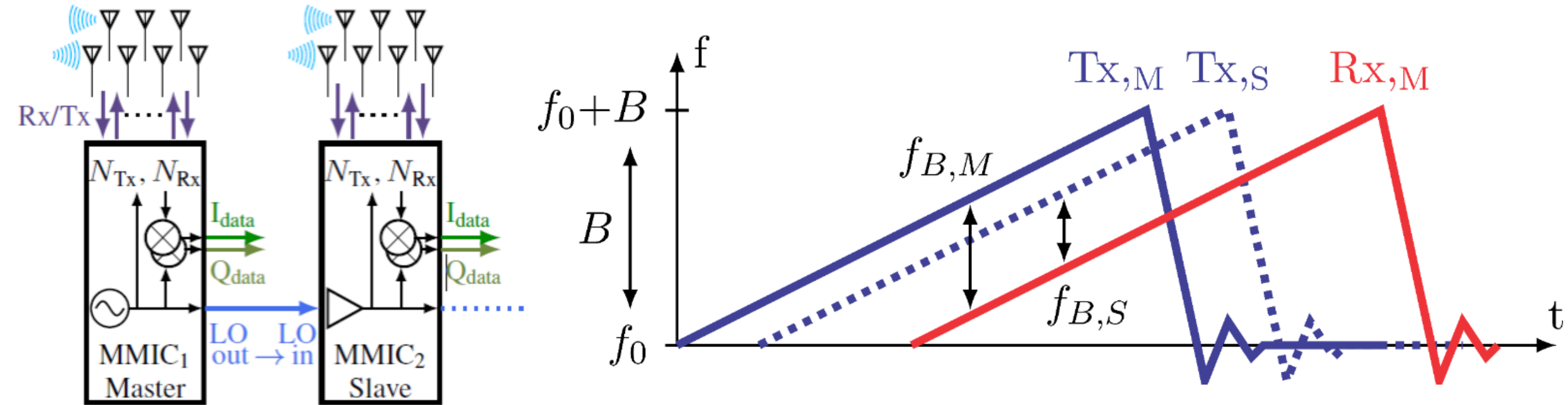


# Next Generation Radar Sensor

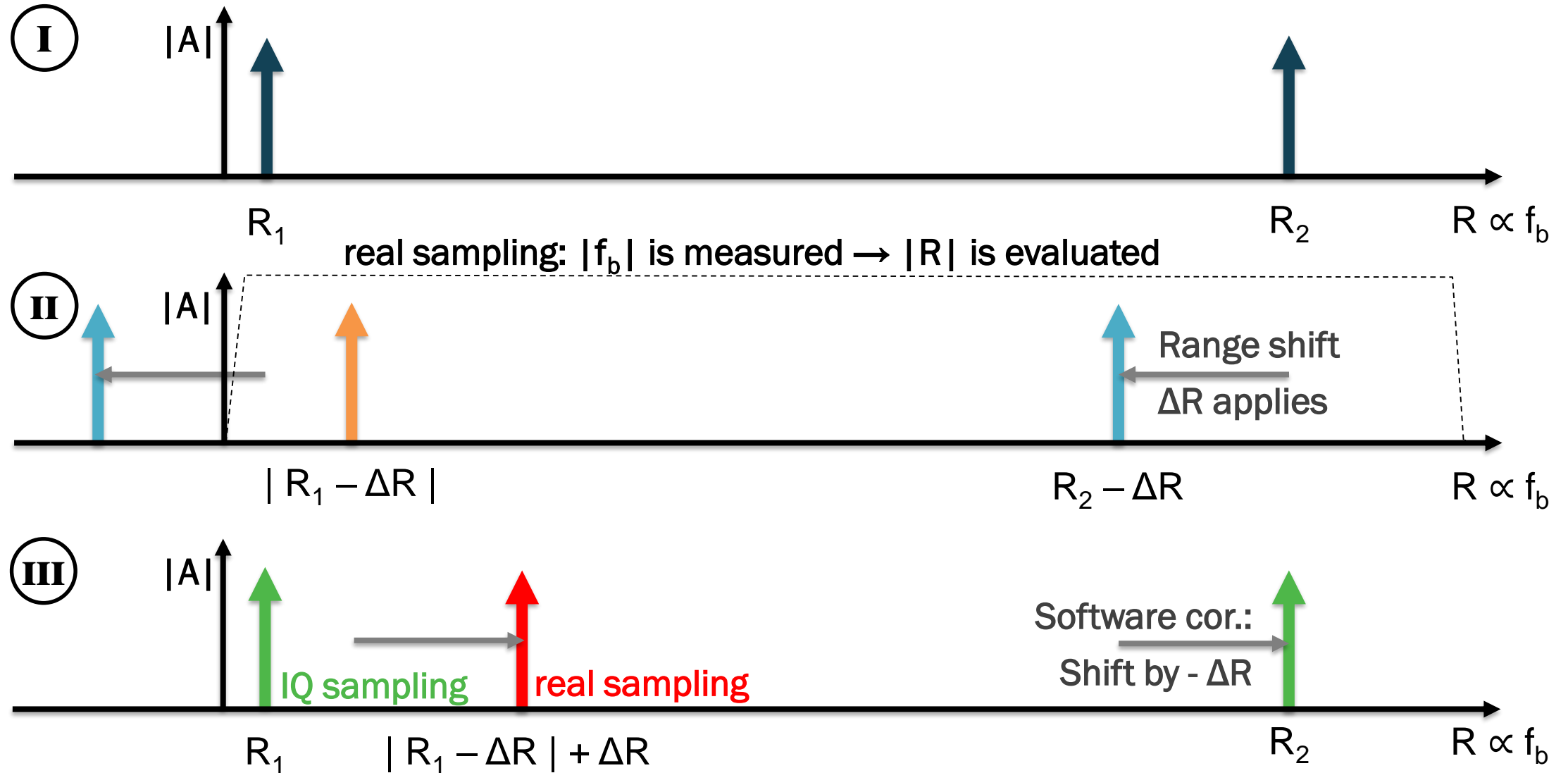


# Range Shift for LO Feedthrough

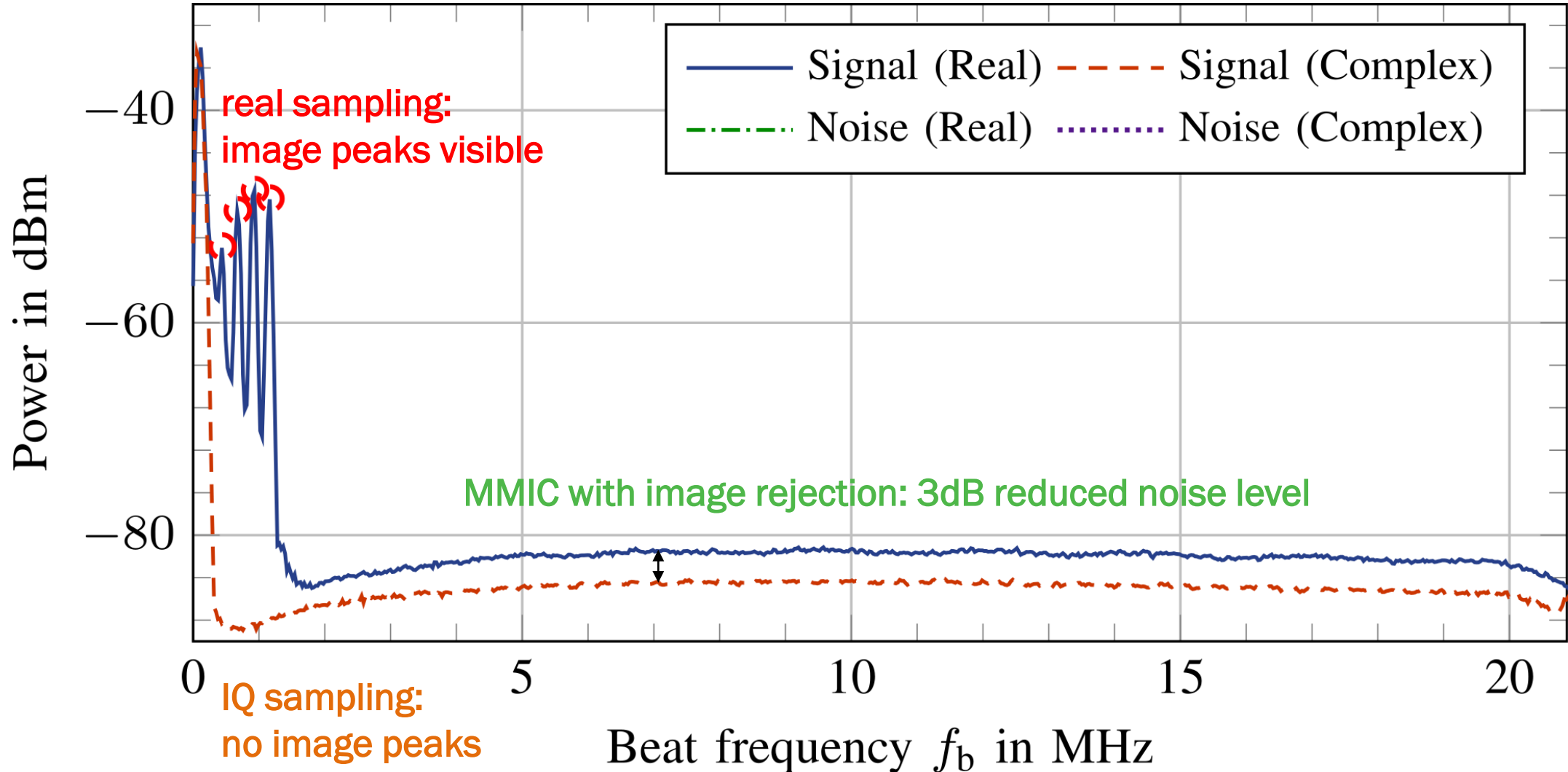
- Ramp signal is delayed on other MMICs



- Reduced beat frequency, target seams closer
- Other MMICs transmitting: target seams further apart





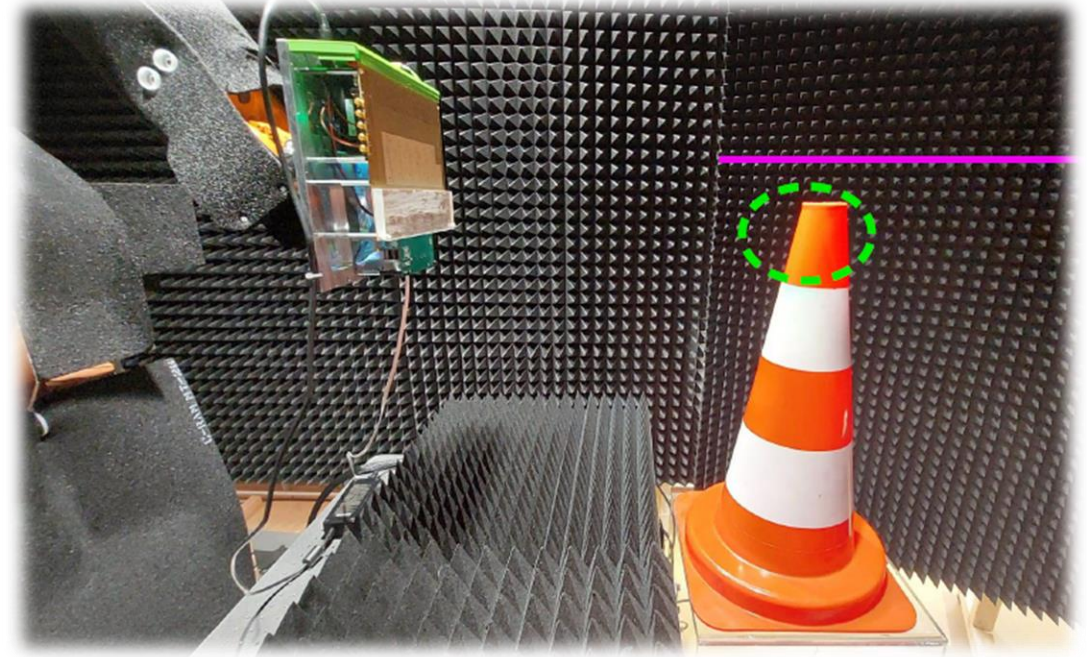




# Short-Range Parking Scenario

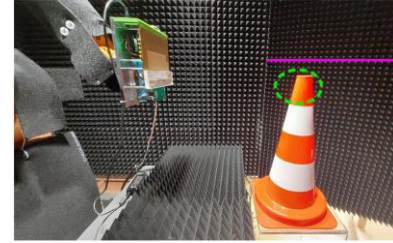


[1]

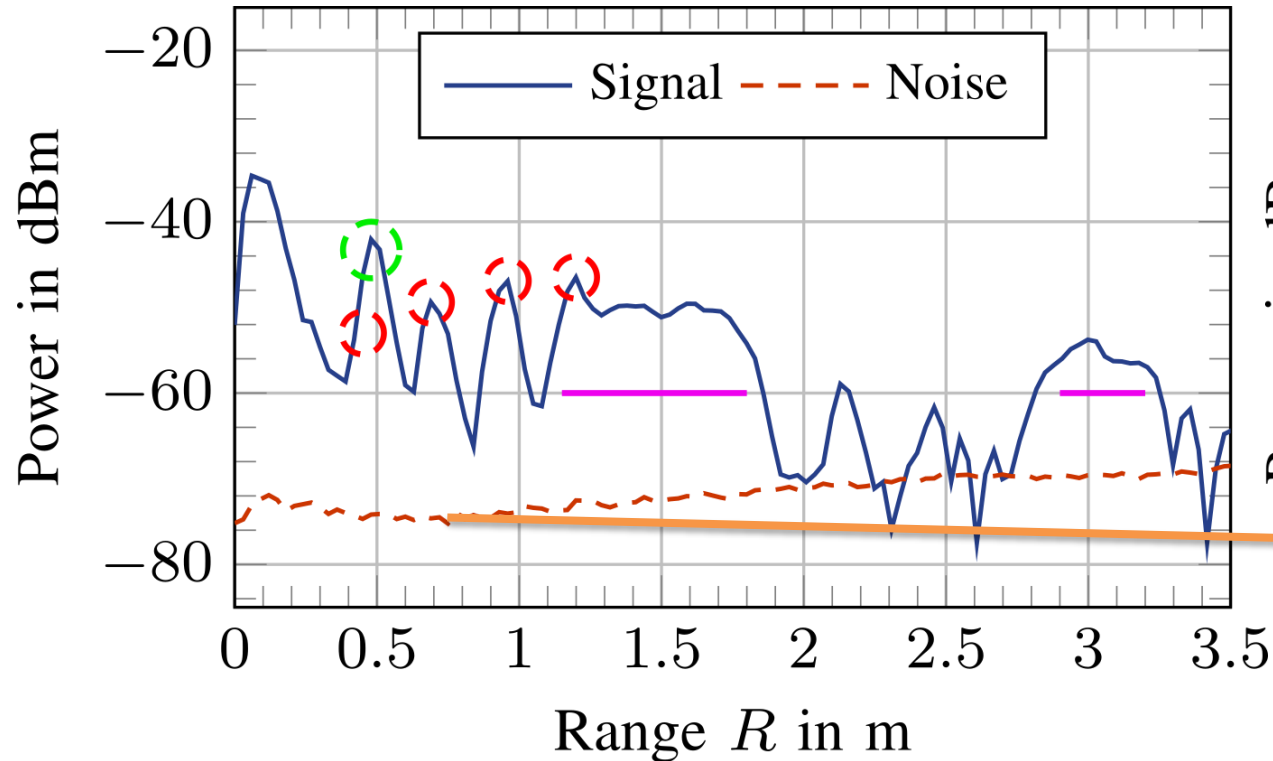


[1] S. Sun et al., "MIMO Radar for Advanced Driver-Assistance Systems and Autonomous Driving: Advantages and Challenges," IEEE Signal Processing Magazine, vol. 37, no. 4, Jul. 2020.

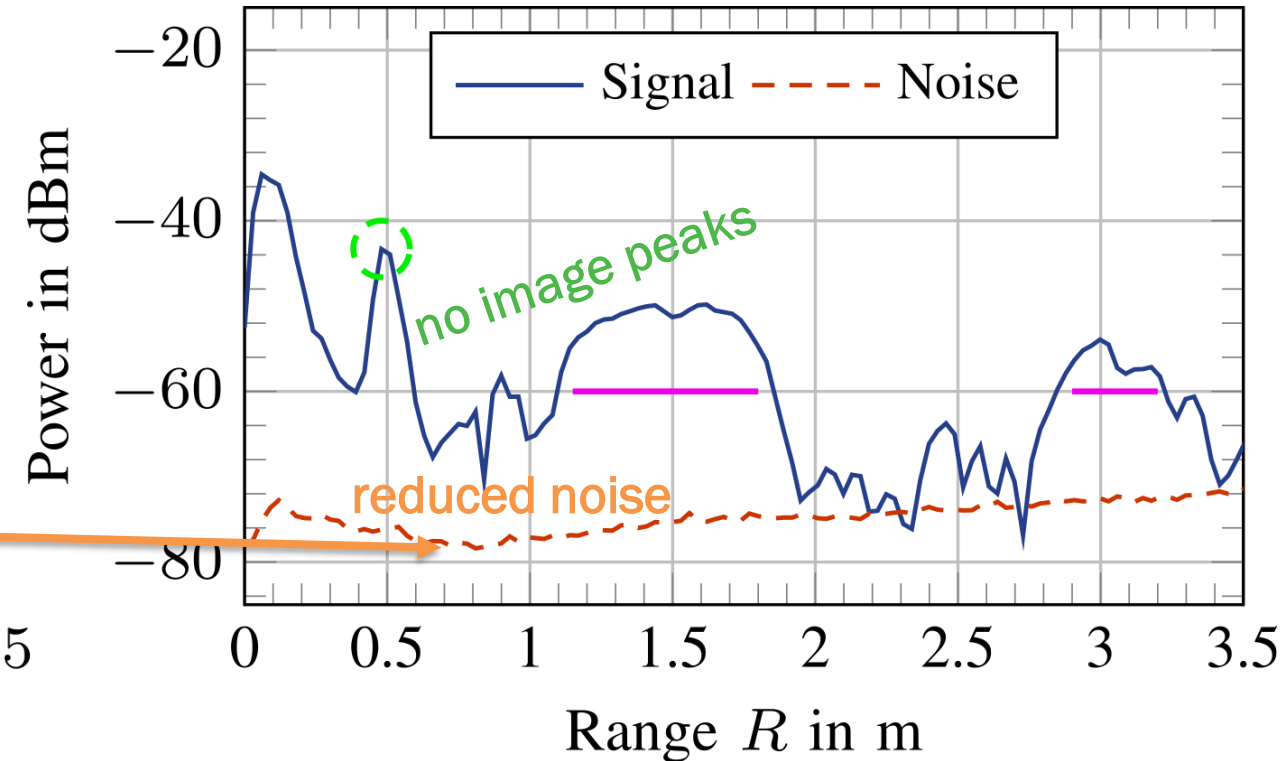
- Complex sampling: no image peaks, reduced noise



real sampling



complex sampling

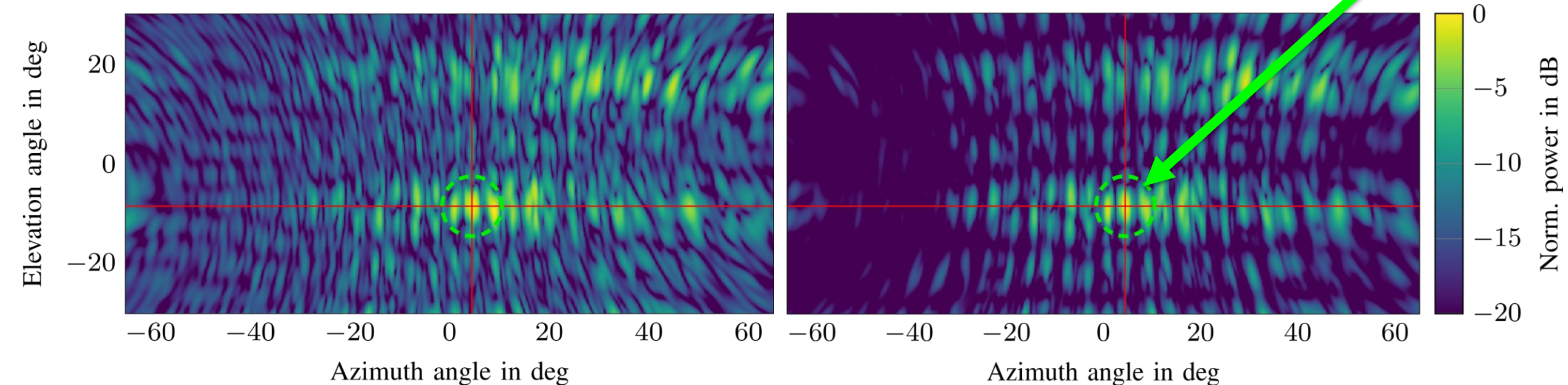
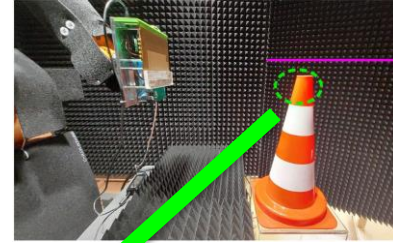




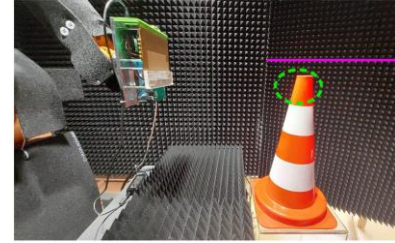
- Complex sampled case: reduced SLL in DoA est.

real sampling

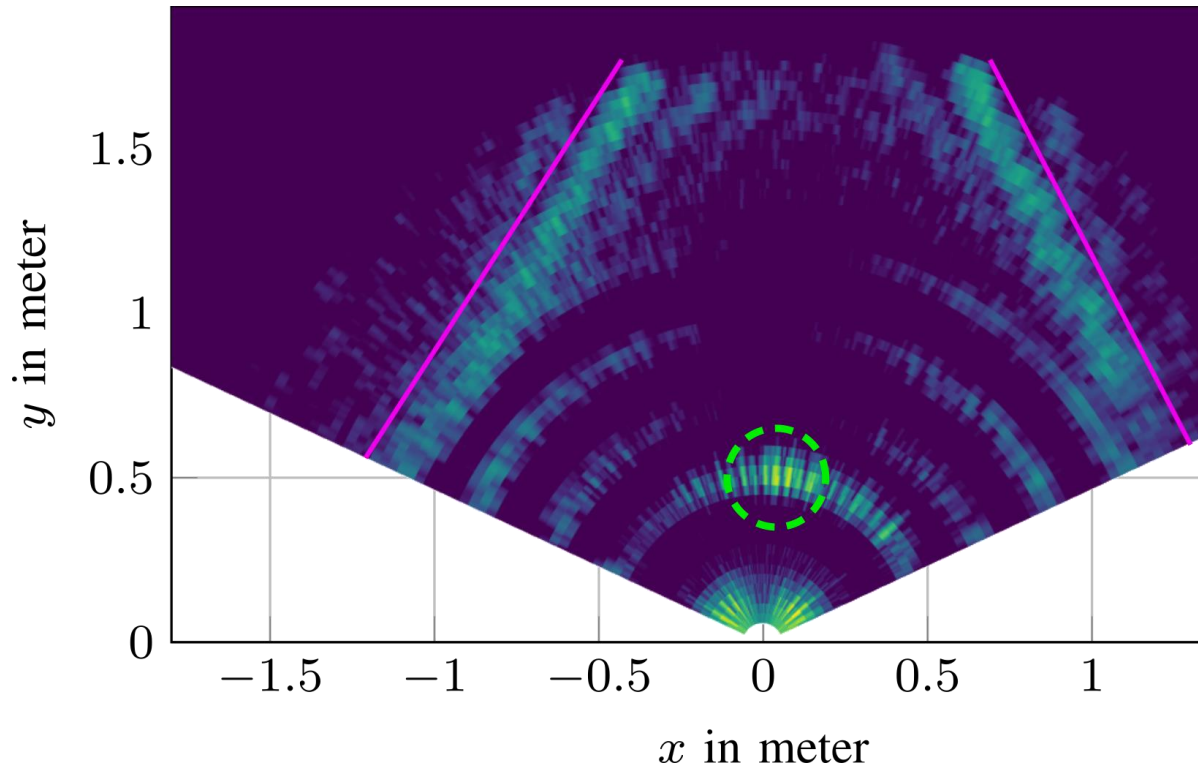
complex sampling



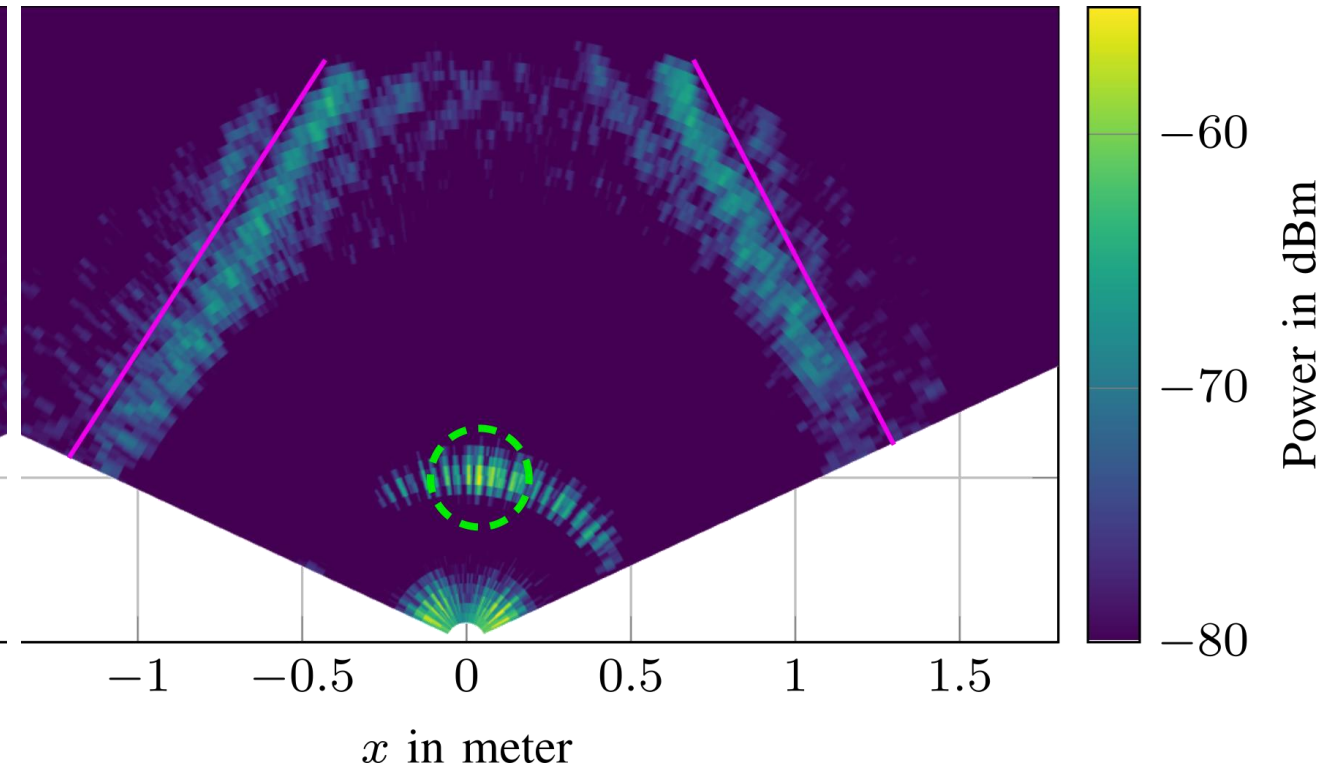
- Real sampling: image peaks  $\rightarrow$  circular distortions



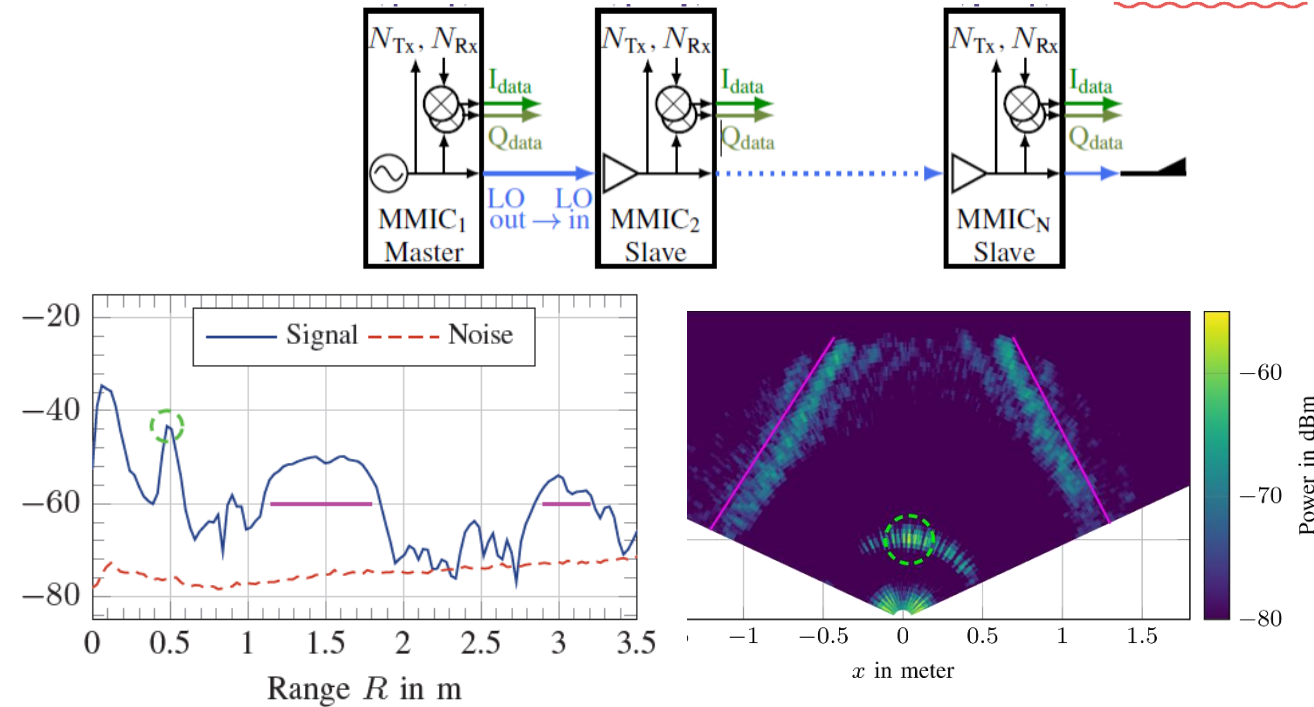
real sampling



complex sampling



- LO Feedthrough convenient for high-resolution radars
  - No distribution networks
  - Easy correction of range shift



- Complex sampling ✓
  - No image peaks due to correction
  - Reduced noise level

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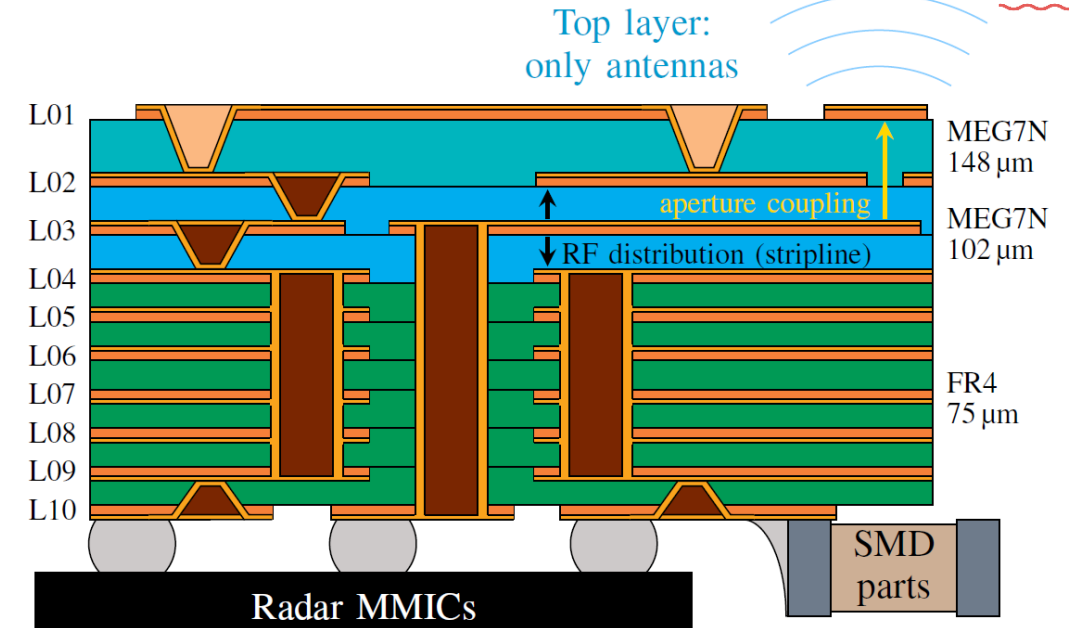




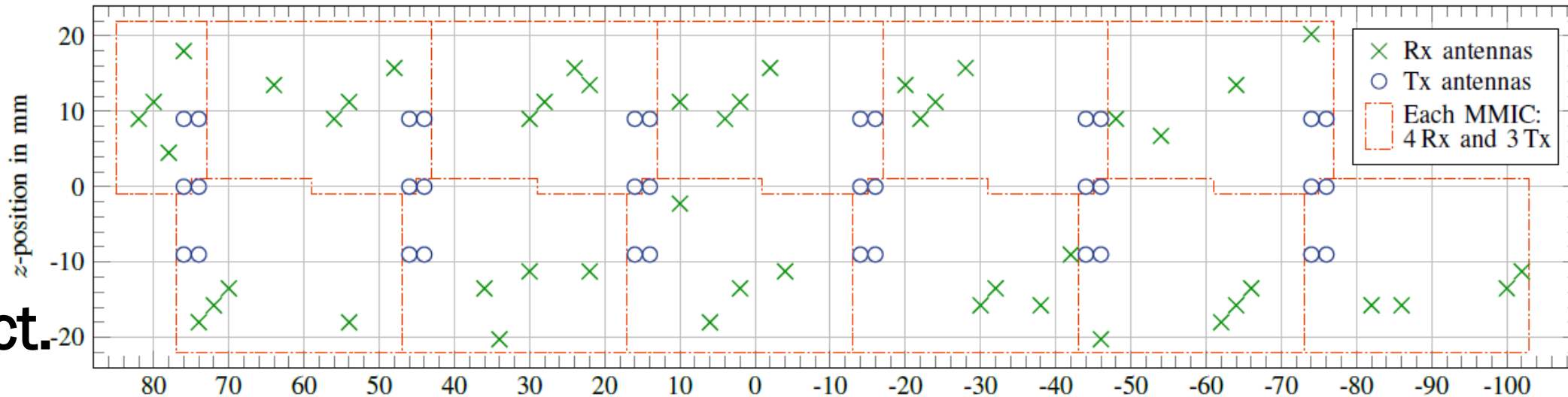
# Backup Slides

# Next Generation Radar Sensor

- No parasitic Radiation
- MMICs under antennas
  - Min. loss
  - Free antenna placement



- 85 X
- 14  $\lambda_0$
- 38 %  
Fill Fact.



# System Performance

